Wheat, Genetically Engineered

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Introduction

Wheat is one of the most versatile and important of all crop plants. It is the chief ingredient in many types of bread, the “staff of life” in many human cultures, and it is cultivated on every continent except Antarctica. In many regions where food insecurity is the all too frequent portal to hunger and starvation, the ability to grow wheat is essential to the survival of the population. One billion people on Earth experience hunger. For another billion people whose diets are unhealthy, where obesity and diseases such as Type II diabetes are prevalent, wheat and other abundant agricultural products permit safer food preparation practices.

Drought, insect infestations, frost, and specific fungal crop diseases are the most common causes of the crop failures that lead to food shortages. Genetically-engineered wheat is specifically formulated to counter the effects of one or more of these threats. Biologists are able to introduce the desirable genetic components of wheat varieties proven to increase crop yields into target species that enhance the ability of the modified wheat strain to resist damage.

The efforts of the agricultural industry to promote genetically-modified wheat as a solution to crop failure have met with staunch resistance from numerous scientific and environmentalist sources. The single greatest concern expressed regarding genetically-modified wheat is that the genes that permit hardier crops and greater yields will contaminate all plants in the vicinity of the modified crops, with untold harm caused to entire ecosystems as mutant “super weeds” take control of the available arable land. The progenetics lobby counters with the argument that such fears are not only unfounded, they are the product of a romantic ideology in which the small farmer who saves seeds for next year's crop is preferred to the science that can save entire populations. Although no western country currently permits the sale or distribution of foods that are produced from genetically-modified wheat, it is anticipated that genetically-modified wheat will remain one of the most controversial aspects of global agriculture for the foreseeable future.

Historical Background and Scientific Foundations

Biologists have long understood the relationship between the genetic structure of plants, including those used for agriculture, and their respective abilities to withstand external stresses on their growth cycles such as drought or *Fusarium* fungi and other pest infestations.

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WORDS TO KNOW

**FOOD INSECURITY:** The phrase used to describe any set of conditions in which a human population is threatened by hunger or starvation. Climatic conditions such as drought and frost can reduce harvests, as can insect infestations and crop diseases. Human conditions such as war or political instability will also often contribute to food insecurity.

**FUSARIM:** A common fungal disease that destroys wheat prior to the wheat reaching maturity. Fusarim is a specialized strain of mycotoxins that impair the healthy development of wheat and pose a significant threat to human and animal health when introduced into the food chain.

**GENETICALLY MODIFIED (GM) FOODS:** GM foods are those in which the original genetic traits are altered to improve a specific crop feature. Drought resistance, herbicide tolerance, enhanced nutritional capacity, and protections against insects are the most common GM objectives. GM foods include crop plants such as corn, rice, and wheat.

**GERMPLASM:** The collected genetic resources of an organism. A seed collection is the stored germplasm for a crop variety.

**TERMINATOR TECHNOLOGY:** A technology that uses genetic modification to render the second generation seeds of a plant sterile. The technology was developed by the United States Department of Agriculture (USDA) and private industry partners and patented in 1998.

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The first hybrid grain was created when wheat and rye germplasms were crossed in 1875.

In the twenty-first century the continued effects of drought experienced in many regions, military conflicts that disrupt food supplies, and the pressure exerted by global population growth have each contributed to the interest in genetic modification techniques as a means to increase crop yields. The techniques have a common scientific foundation. Plant genes identified with a desired trait are either synthesized or chemically extracted from the source plant. The desired genes are inserted into the target plant when source plant proteins that contain the genes are injected into the target plant. Cytokinin is the protein commonly employed to promote the cell division necessary to establish the newly injected genes within the cell structure of the target.

In 1986 tobacco was first plant to be genetically modified; plant tolerance to insect attack was increased through the introduction of a specific insect-resistant gene. The potential to modify wheat and other food crops to improve crop yields seemed limitless. The concerted opposition to genetic modification grew in the 1990s as the risks to human health and the environment posed by contact with or consumption of genetically modified crops were not entirely resolved.

The United States and China have been prominent advocates of modified wheat research. The European Union adopted a far more stringent approach to the use of all genetically modified crops; each product introduced to the market is classed as a “new food” that must undergo its own stringent testing before it is permitted for human or animal consumption.

Impacts and Issues

The overarching global questions associated with food security and food quality are distinct social and scientific issues. It is difficult to argue against the theoretical merits of the objectives associated with the development of genetically modified wheat. Any crop plant whose improved cultivation contributes to a surer and more stable food supply in hunger-plagued global regions such as sub-Saharan Africa is inherently desirable. The Group of 20 (G20) nations are among the international organizations that have supported genetic wheat research, through their contributions to the International Research Institute for Wheat.

The chief problem with genetically modified crop plants of any kind is the persistence of the element



*Genetically engineered wheat (Triticum aestivum), into which a naturally occurring gene was reintroduced to reduce allergenicity, grows in a greenhouse at University of California, Berkeley. © inga spence/Alamy.*

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*Wheat grows on a hillside in Yunnan Province in the southwest of China. In 2009, China approved its first strain of locally-developed, genetically modified rice for commercial production. China is the world's biggest grain producer, but also has the world's largest population, so the government wants to raise grain production and has been investing billions on GMO research on rice, corn, and wheat. © Raywoo/Shutterstock.com.*

of the unknown. The ability of science to produce a genetically modified plant species that resists one or more of the common causes of crop failure is undoubted. Genetic modification of wheat varieties has been proven to achieve greater drought, pest, and fungal disease resistance. The unknown that prompts the outrage expressed by the well-organized lobbies that have opposed the sale and distribution of such wheat products is the uncontrolled spread of genetic pollution through any plant species that comes into contact with the modified wheat. There is no concrete evidence on either side of the issue that confirms what the effects of genetically modified wheat might be on adjacent grasses, trees, or other living things. The effects on human health posed by the consumption of modified wheat have not been determined conclusively. The uncertainty that surrounds consumption of genetically modified food of all kinds is rooted in fears that include potential alterations within the human genome, the heightened allergenicity of introduced genes, and high toxin production.

The secondary problem frequently associated with genetically modified wheat is the cost associated with purchasing the necessary seeds to cultivate new wheat varieties by small scale farmers in the developing world. It is estimated that in drought- and famine-ravaged countries such as Ethiopia, more than 90 percent of the wheat currently grown is the product of “farm saved seed.” The purchase cost of genetically modified seed would exceed $70 million per year in this subsistence agricultural society, a sum that would sharply increase the market price of an already scarce food commodity. The value of increased crop yields and improved food security versus these costs is an unproven relationship.

Tied to these cost concerns is the perception that multinational agribusiness will profit from genetically-modified wheat seed. Companies such as Monsanto that hold the patents to the seeds marketed in developing countries stand to reap significant gains from the introduction of these products into the global agricultural mainstream.

**SEE ALSO** [*Agricultural Biotechnology*](http://go.galegroup.com/ps/retrieve.do?inPS=true&prodId=GVRL&userGroupName=dove10524&tabID=T003&searchId=R1&searchType=BasicSearchForm&contentSet=GALE&docId=GALE%7CCX4020200015) *;* [*Agrobacterium*](http://go.galegroup.com/ps/retrieve.do?inPS=true&prodId=GVRL&userGroupName=dove10524&tabID=T003&searchId=R1&searchType=BasicSearchForm&contentSet=GALE&docId=GALE%7CCX4020200016) *;* [*Bt Insect Resistant Crops*](http://go.galegroup.com/ps/retrieve.do?inPS=true&prodId=GVRL&userGroupName=dove10524&tabID=T003&searchId=R1&searchType=BasicSearchForm&contentSet=GALE&docId=GALE%7CCX4020200074) *;* [*Corn, Genetically Engineered*](http://go.galegroup.com/ps/retrieve.do?inPS=true&prodId=GVRL&userGroupName=dove10524&tabID=T003&searchId=R1&searchType=BasicSearchForm&contentSet=GALE&docId=GALE%7CCX4020200086) *;* [*Disease-Resistant Crops*](http://go.galegroup.com/ps/retrieve.do?inPS=true&prodId=GVRL&userGroupName=dove10524&tabID=T003&searchId=R1&searchType=BasicSearchForm&contentSet=GALE&docId=GALE%7CCX4020200097) *;* [*Drought-Resistant Crops*](http://go.galegroup.com/ps/retrieve.do?inPS=true&prodId=GVRL&userGroupName=dove10524&tabID=T003&searchId=R1&searchType=BasicSearchForm&contentSet=GALE&docId=GALE%7CCX4020200104) *;* [*Frost-Resistant Crops*](http://go.galegroup.com/ps/retrieve.do?inPS=true&prodId=GVRL&userGroupName=dove10524&tabID=T003&searchId=R1&searchType=BasicSearchForm&contentSet=GALE&docId=GALE%7CCX4020200120) *;* [*Gene Banks*](http://go.galegroup.com/ps/retrieve.do?inPS=true&prodId=GVRL&userGroupName=dove10524&tabID=T003&searchId=R1&searchType=BasicSearchForm&contentSet=GALE&docId=GALE%7CCX4020200125) *;* [*Plant Variety Protection Act of 1970*](http://go.galegroup.com/ps/retrieve.do?inPS=true&prodId=GVRL&userGroupName=dove10524&tabID=T003&searchId=R1&searchType=BasicSearchForm&contentSet=GALE&docId=GALE%7CCX4020200196) *;* [*Salinity-Tolerant Plants*](http://go.galegroup.com/ps/retrieve.do?inPS=true&prodId=GVRL&userGroupName=dove10524&tabID=T003&searchId=R1&searchType=BasicSearchForm&contentSet=GALE&docId=GALE%7CCX4020200210) *;* [*Terminator Technology*](http://go.galegroup.com/ps/retrieve.do?inPS=true&prodId=GVRL&userGroupName=dove10524&tabID=T003&searchId=R1&searchType=BasicSearchForm&contentSet=GALE&docId=GALE%7CCX4020200232) *;* [*Transgenic Plants*](http://go.galegroup.com/ps/retrieve.do?inPS=true&prodId=GVRL&userGroupName=dove10524&tabID=T003&searchId=R1&searchType=BasicSearchForm&contentSet=GALE&docId=GALE%7CCX4020200238)

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***Bryan Thomas Davies***

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Text dependent questions

1. What is the biggest concern scientists have regarding the genes contained in genetically modified wheat and other GMO crops?
2. What are three factors in the 21st century that have increased interest in genetic modification of crops as a means of improving yields?
3. What role does the protein cytokinin play in the role of developing genetically modified plants?
4. What kind of concrete evidence is there on the effects of genetically modified wheat on surrounding wild plants?
5. What kind of economic concerns do genetically modified crops pose for developing countries?